Raytheon

Generalized Automated Maintenance Environment

Objectives

- Overview of gAME and What Has Been Accomplished
- Overview of How it Works
- Additional Capabilities
  - Modify the Maintenance Plan
  - Offline Toolkit
- Conclusion

Raytheon and AME

- Successfully Responded to a BAA from ONR and PMA-265
  - Provide a COTS IDE to support the F/A-18 AME
  - Solutions must be open architecture and generalized in applicability.
    - Not weapon system or aircraft platform specific
- Formed a team of vendors providing world class software solutions, resulting in the generalized Automated Maintenance Environment (gAME)
- F/A-18 E/F OPEVAL chose core asset management component as ECAMS Replacement
  - Selected to use gAME architecture approach as risk mitigation to OOMA support of OPEVAL
    - Referred to as SuperHornet AME (sAME)

gAME

Objective: generalized Automated Maintenance Environment (gAME)

- To provide customers an open architecture infrastructure to provide for integrating COTS software and legacy solutions.
- Use existing communications systems to provide all supportability requirements and improve the readiness of our weapons & defense systems.
- The generalized AME will further improve the effectiveness of the maintainers by providing electronic training and assistance while providing “real-time” support for battle damage assessment in times of conflict.

Key Features

- generalized AME team provides an integrating infrastructure
  - Open architecture environment
  - Make full use of legacy investments
  - Easily integrates into existing Information Systems
    - Mission Planning
    - Training
    - Depot Repair and CLS
    - Parts Distribution
  - Compliant with a DoD related initiatives
- Provides digital supportability information increasing the timeliness and accuracy of data.

Key Features (con't)

- Totally COTS based
  - Provides transparent insertion of new latest computer technology with little or no cost to the customer.
  - Customer costs are based on scaleable use fee
    - Can be implemented by platform, or by function
- Provides:
  - Component Base Tracking
  - Network and Satellite connectivity
  - Configuration/Asset Management
  - Logistics Planning Tools
  - Prognostics/Diagnostics
  - Training
  - Reporting
  - Depot Activities
  - Base Supply and Parts Distribution

What's Been Accomplished?

- Built an integrated team of domain experts.
- Provided Core Configuration/Asset Management module to support F/A-18 E/F OPEVAL (sAME)
  - Interfaced with existing functional technology investments.
    - IETM's
    - Pilot Debrief
    - Data Stripping Unit
    - Life Usage Index (LUI) Calculator
    - Engine Diagnostics
    - Help Request Document (HRD)
  - Developed LAN/WAN architecture for global deployment.

Benefits to F/A-18

- Resolves 10 of 18 Readiness Issues
- Resolved ECAMS Y2K Problem
- Compliments legacy NALCOMIS and other systems with COTS solutions
- Provides Point-Of-Maintenance (POM) entry of data that is integrated with the next level of maintenance.
  - Data collected at O-Level is transmitted to the I-Level.
  - Data collected at I-Level is transmitted to the Depot, and/or OEM.
  - All fleet-wide data is made available at the up-line repositories.
- Provides Annual Cost Savings
  - Multiple legacy systems can be terminated.
  - Eight percent labor cost reduction.
  - Five percent material cost reduction by improved asset management.

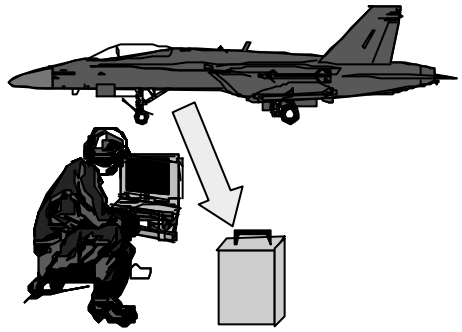
Overview of How it Works

Modules at O-Level

- Download/Data Stripping
- SAFE File Generator
- LUI Calculator
- Applications/Session Manager
- Debrief
- IETMs/HRD(TMDR)
- Configuration/Asset Management
- Engine Diagnostics

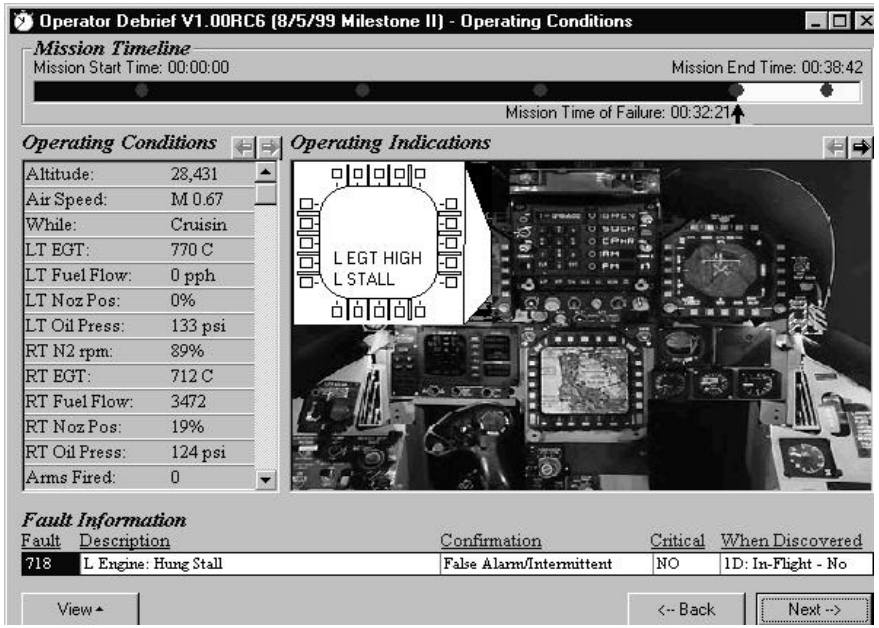
A Flight→Usage Accrual & Debrief

- **What Occurs:**
  - **An aircraft flies**
  - **The MU is brought in and stripped by the Pilot. The data is copied to ADFs on the AME PC**
  - **The Debrief module is launched at the end of the download**
  - **A pilot validates/adds any faults using the Data Stripping and Debrief modules**
  - **In the background, usage is extracted from the MU data and applied to the aircraft records in Configuration and Asset Management Database**
  - **gAME modules involved:**
    - **Applications/Session Manager**
    - **Data Stripping**
    - **F414 LUI Calculator**
    - **Debrief**
    - **Maintenix/OOMA**



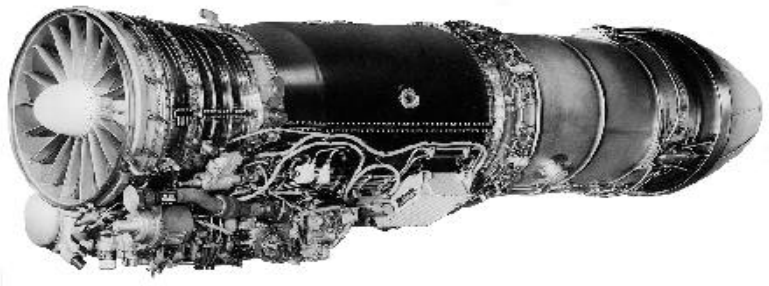
Debrief Logs any Additional Discrepancies

- The pilot reviews the faults identified by the expert system and adds any other discrepancies
- Suggested maintenance tasks are passed to Maintenix/OOMA



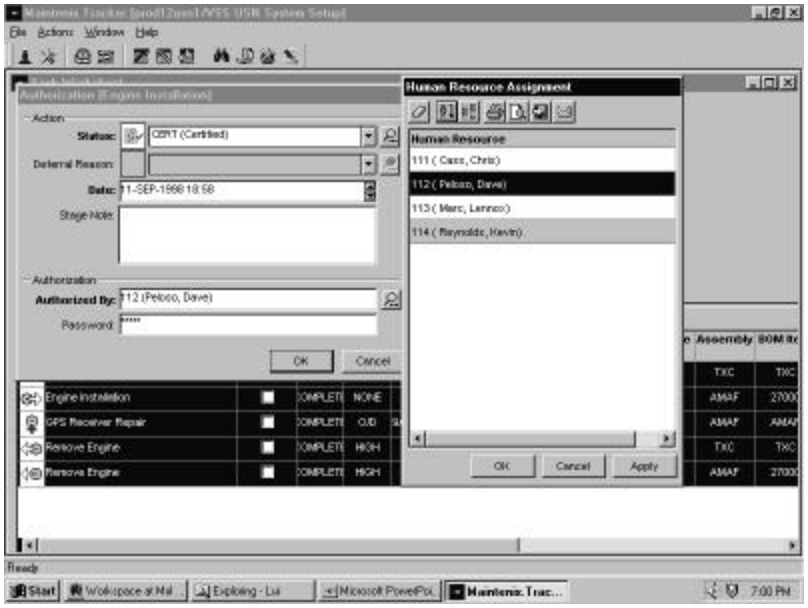
Background Processing of Aircraft Data

- Engine LUIs are extracted from the aircraft data and applied to Maintenix/OOMA
- SAFE files are created with the structural data
- The Engine trending and diagnostics data set is updated with new data



NAVFLIR Completion

- The pilot completes a NAVFLIR in NALCOMIS
- A maintainer enters the landing data in Data Stripping to complete the SAFE file and provide landings as usage data to Maintenix/OOMA



Maintenance Scheduling and Execution

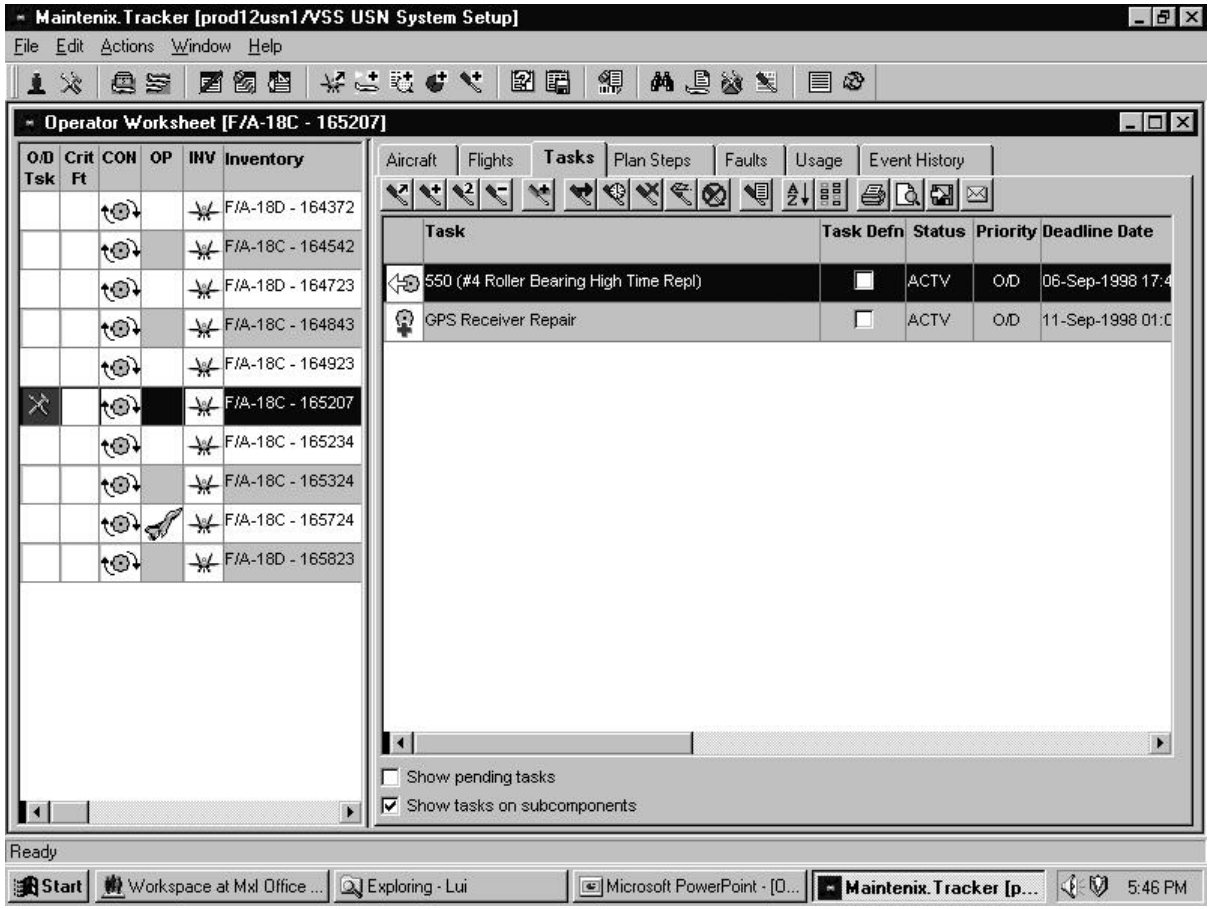
- What Occurs:
  - A maintenance action initiated by Debrief
  - A maintenance action initiated by engine LUI data reaching the life limit
  - The maintenance “due list” for the aircraft automatically updated to reflect the new maintenance actions
  - An engine removal and transfer to IMA for overhaul
  - The aircraft left in an operational state
- gAME modules involved:
  - Maintenix/OOMA
  - Applications/Session Manager
  - IETMs

Auto Scheduling

- Recall
  - The Debrief expert system analysis suggested a maintenance task
  - The Data Stripping process extracted engine usage (LUIs) from the aircraft data and applied it to the engine records in Maintenix/OOMA.
- The Maintenix/OOMA Operator Status Board, as Maintenance Control's "White Board", is automatically updated to show an overdue task for the subject aircraft.

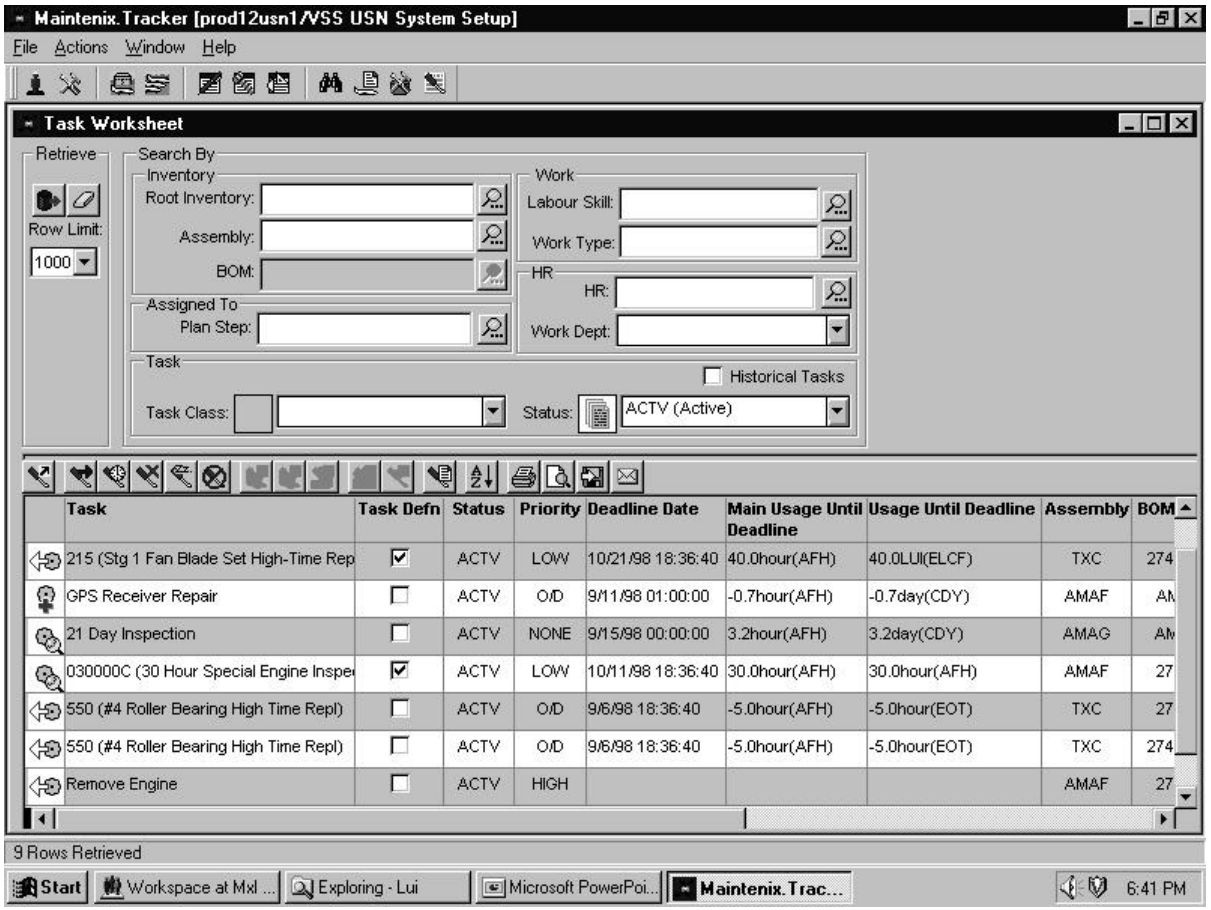
Maintenance Alerted to Aircraft Caution

- The aircraft is shown with overdue tasks
- The maintenance tasks are shown
  - Debrief task is to repair GPS receiver
  - the LUI increase has caused an engine turbine to go 'high-time', requiring an engine removal



Identify Maintenance Tasks

- Maintenix/OOMA shows all upcoming work for the squadron to Maintenance Control
  - Work can be sorted to facilitate planning
- Maintenance Control initiates MAFs NALCOMIS based on the Maintenix tasks



Download IETMS to PEDD

- Session Manager gets a list of maintenance tasks from Maintenix/OOMA
- This information is used to download IETMS links to the PEDD

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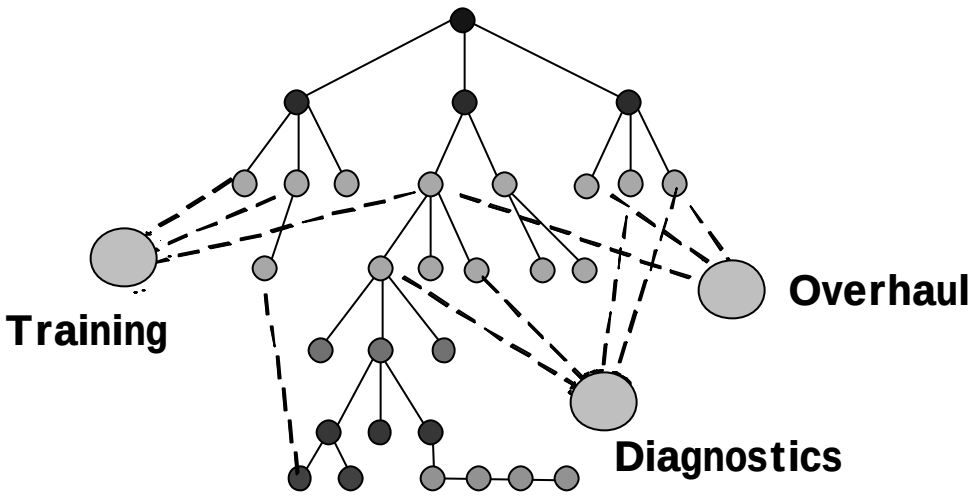
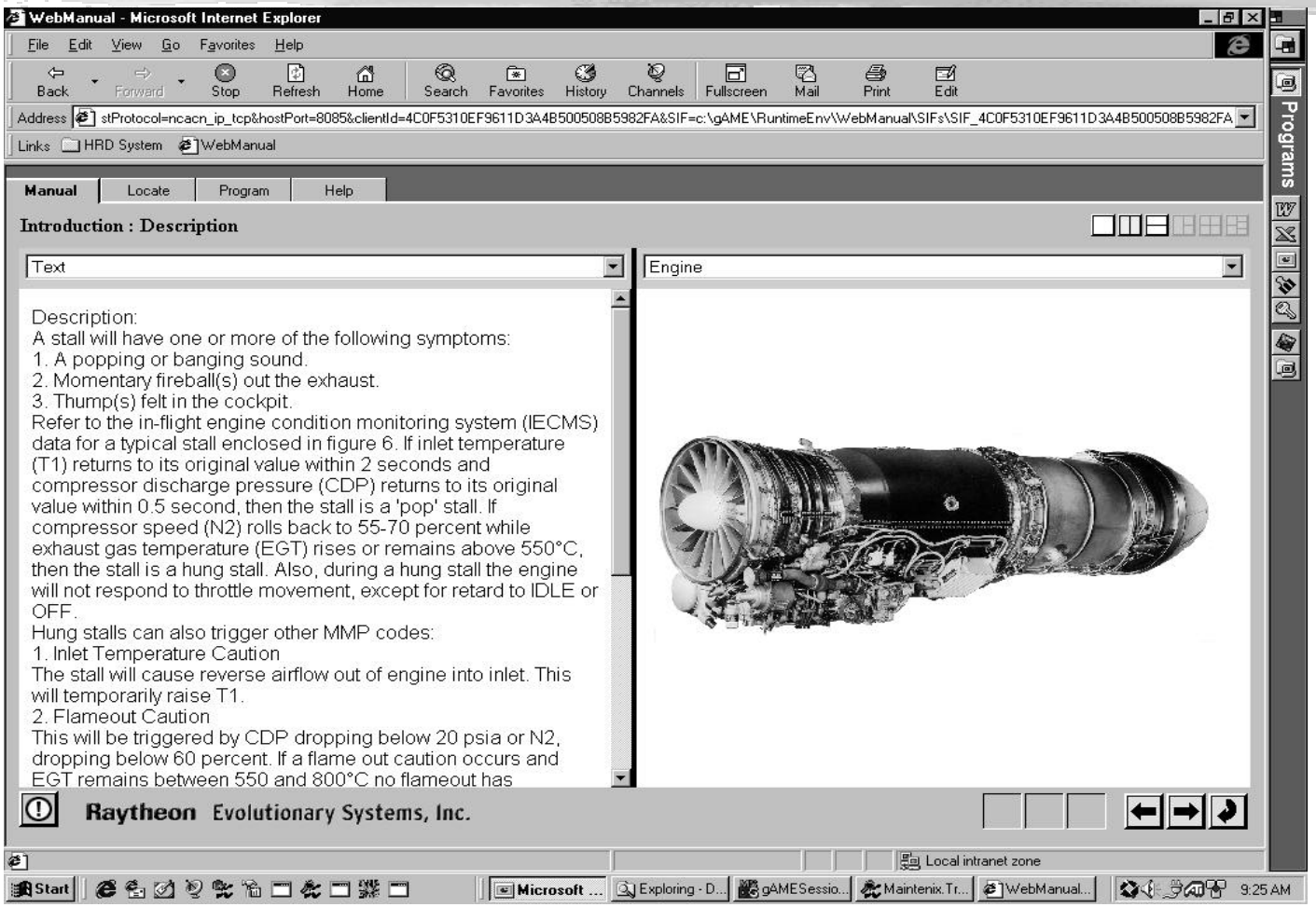
- database
- hierarchical
- non-redundant
- relational links
- context filters



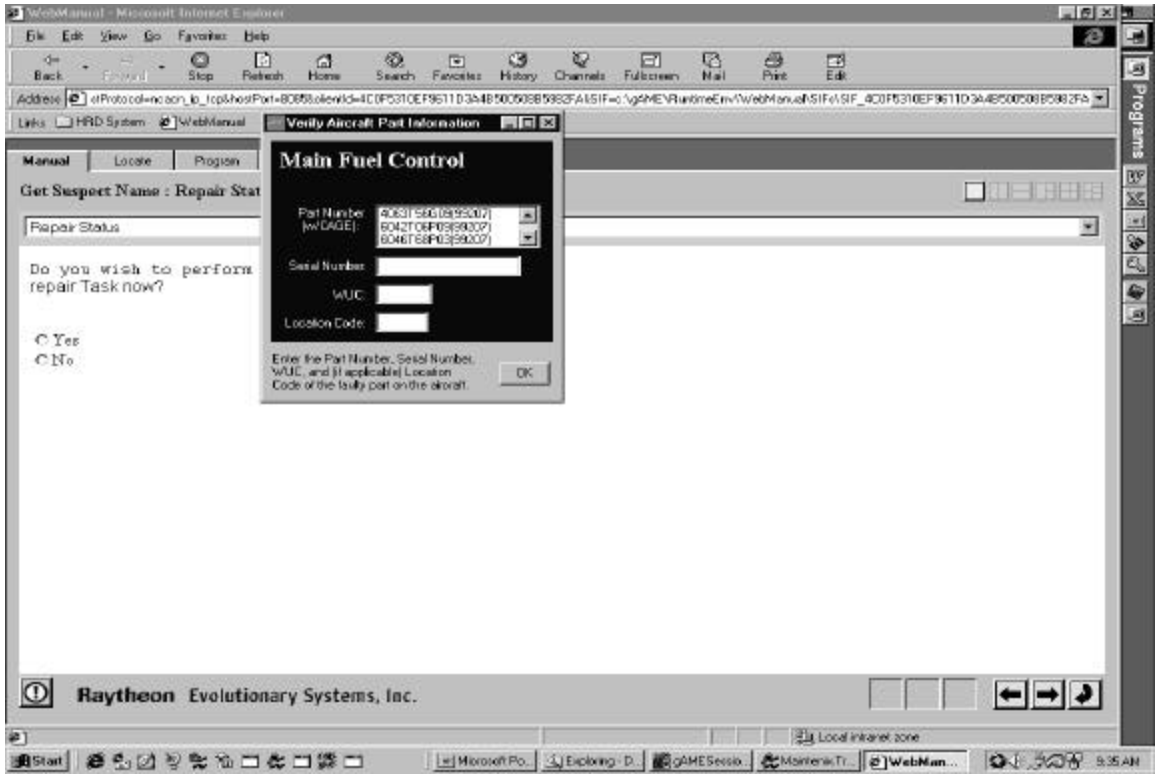
Execute Maintenance Tasks

- The maintainer takes the PEDD out to the aircraft and uses the IETMs while executing the maintenance tasks



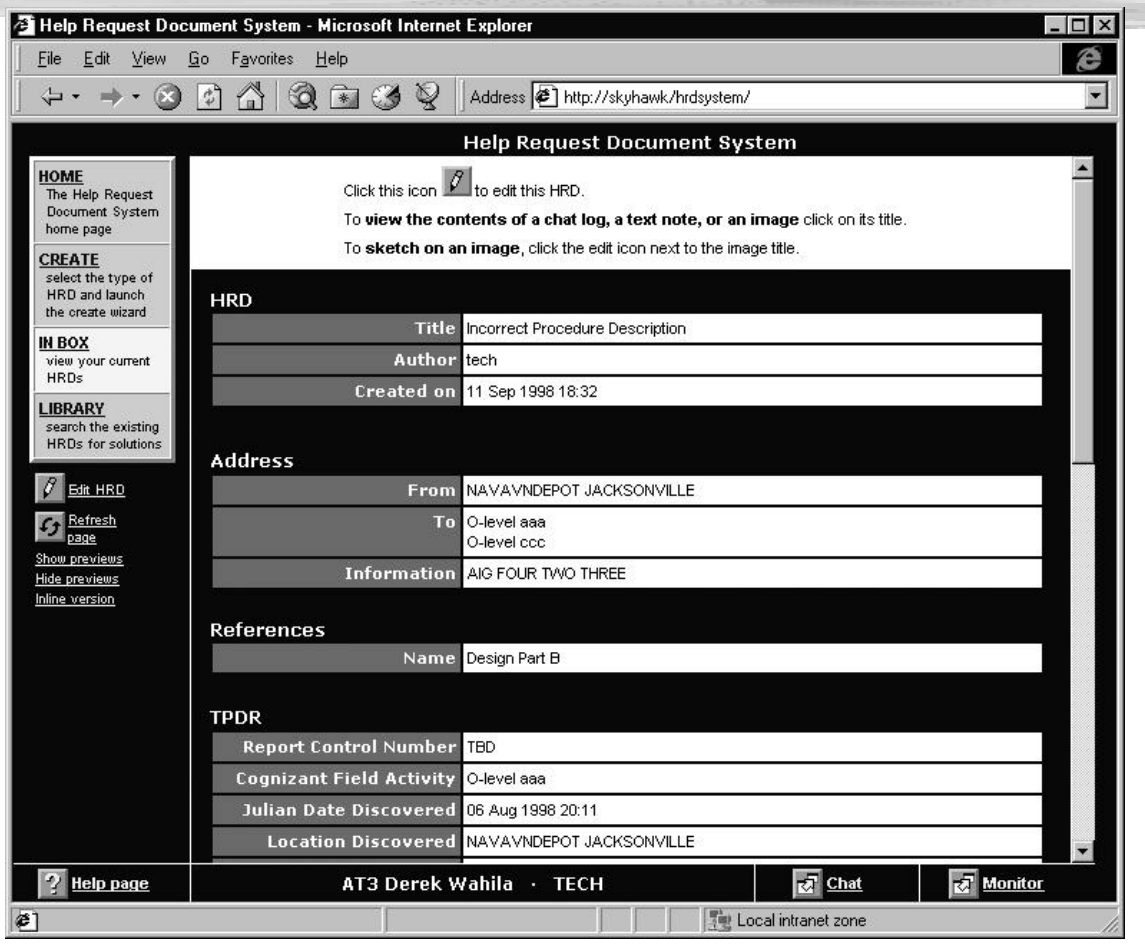
Upload the Maintenance Done from the PEDD

- The PEDD records serialized component changes
- The Session Manager is used to upload the maintenance done on the aircraft into Maintenix



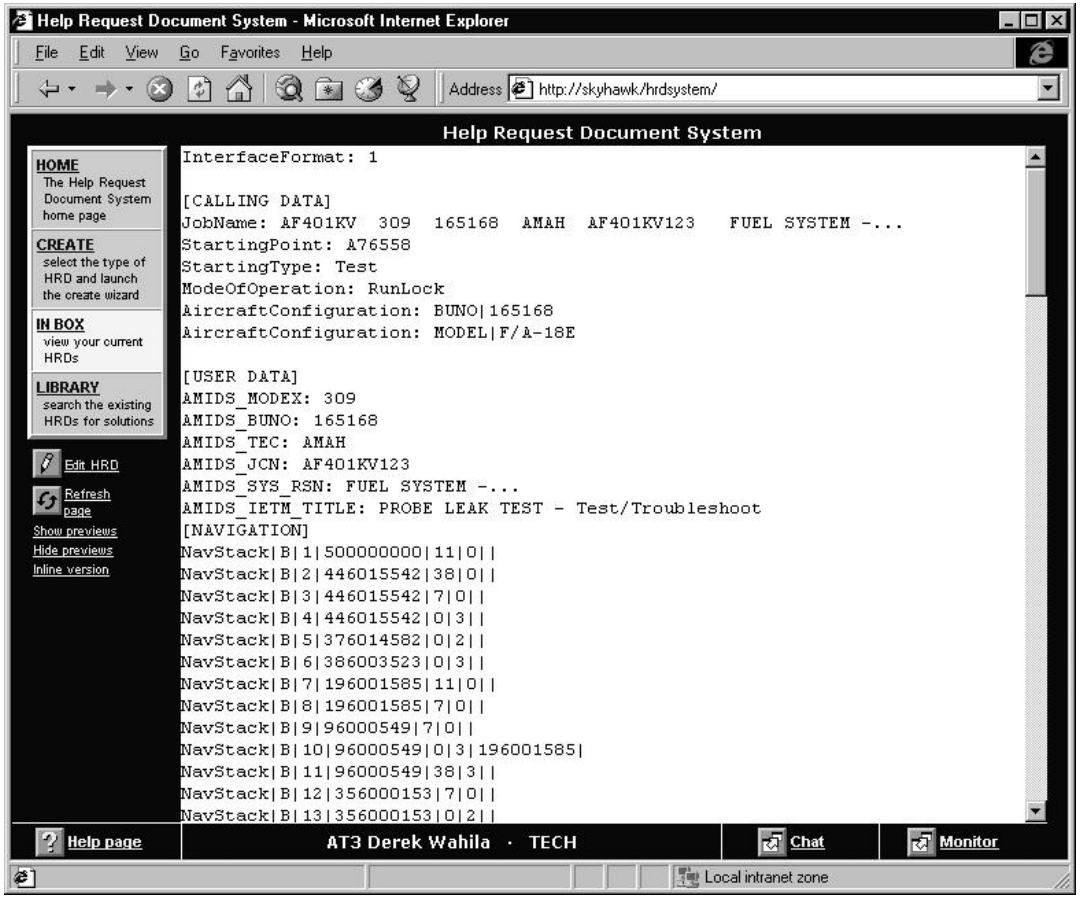
IETMS TPDR

- Create a bookmark in IETMS when a problem is suspected
- Initiate HRD with the IETMS bookmark to create a TPDR



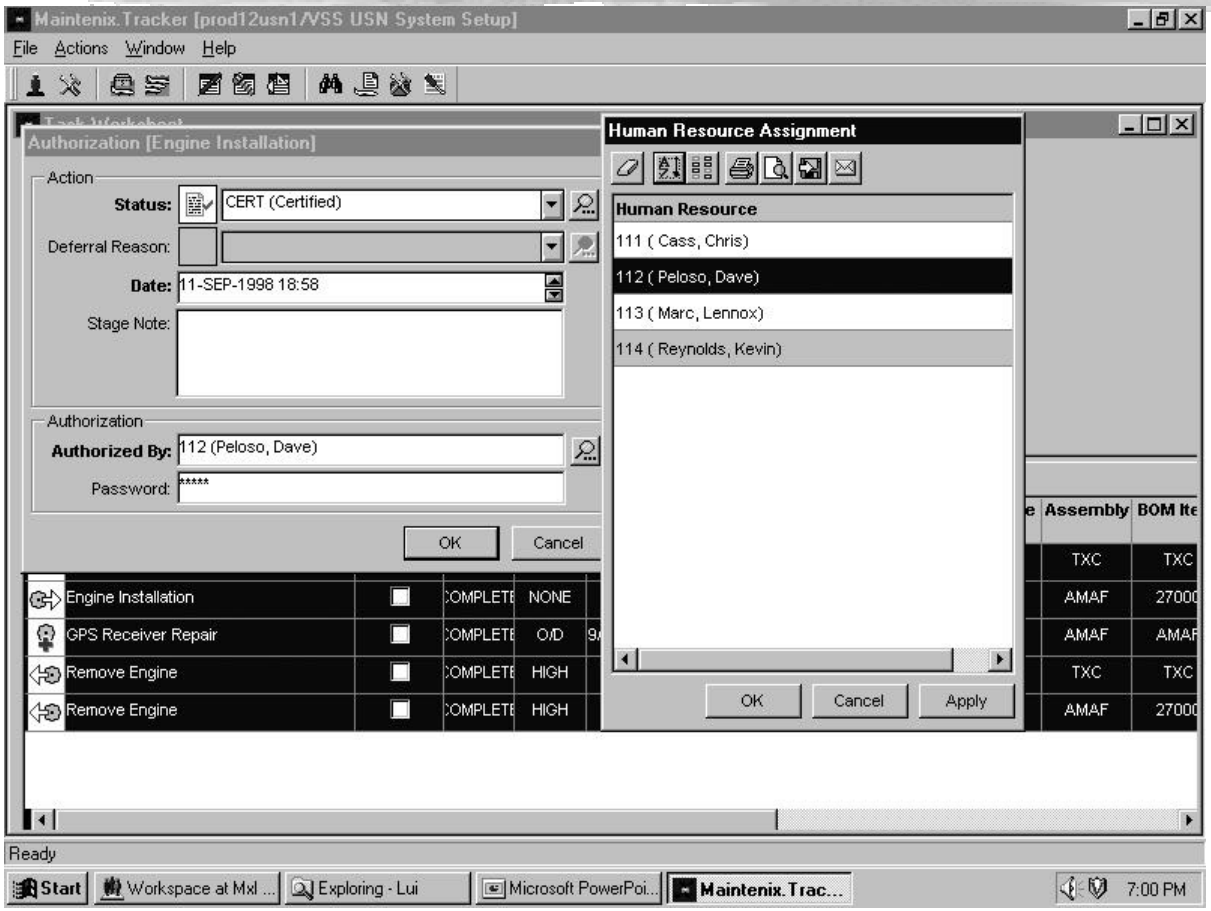
Evaluate the TPDR

- The TPDR is transferred to ISEA by the HRD system
- The TPDR is evaluated and used to update new releases of IETMS



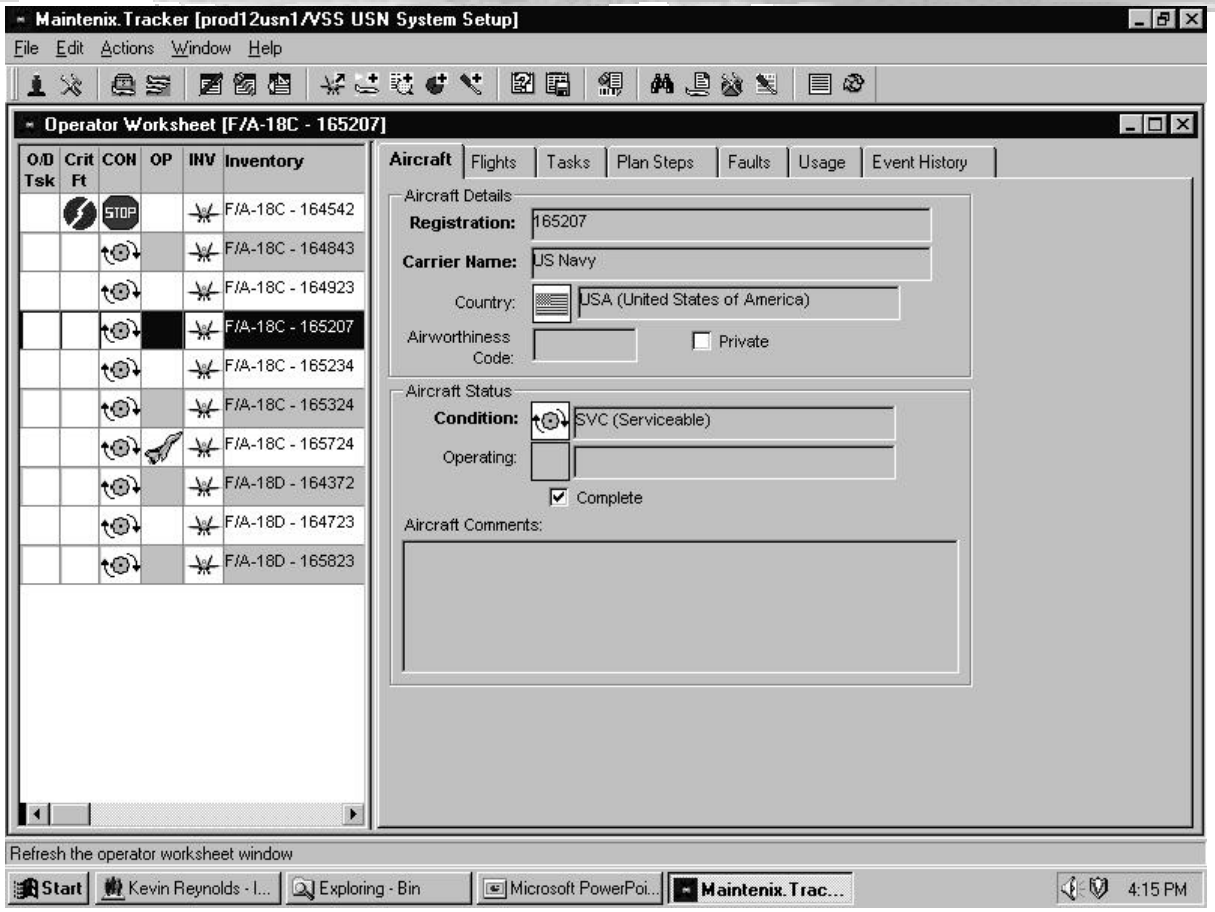
Complete the MAF and sign off the work in Maintenix

- The MAFs are completed in NALCOMIS
- Maintenance Control signs off the uploaded tasks in Maintenix



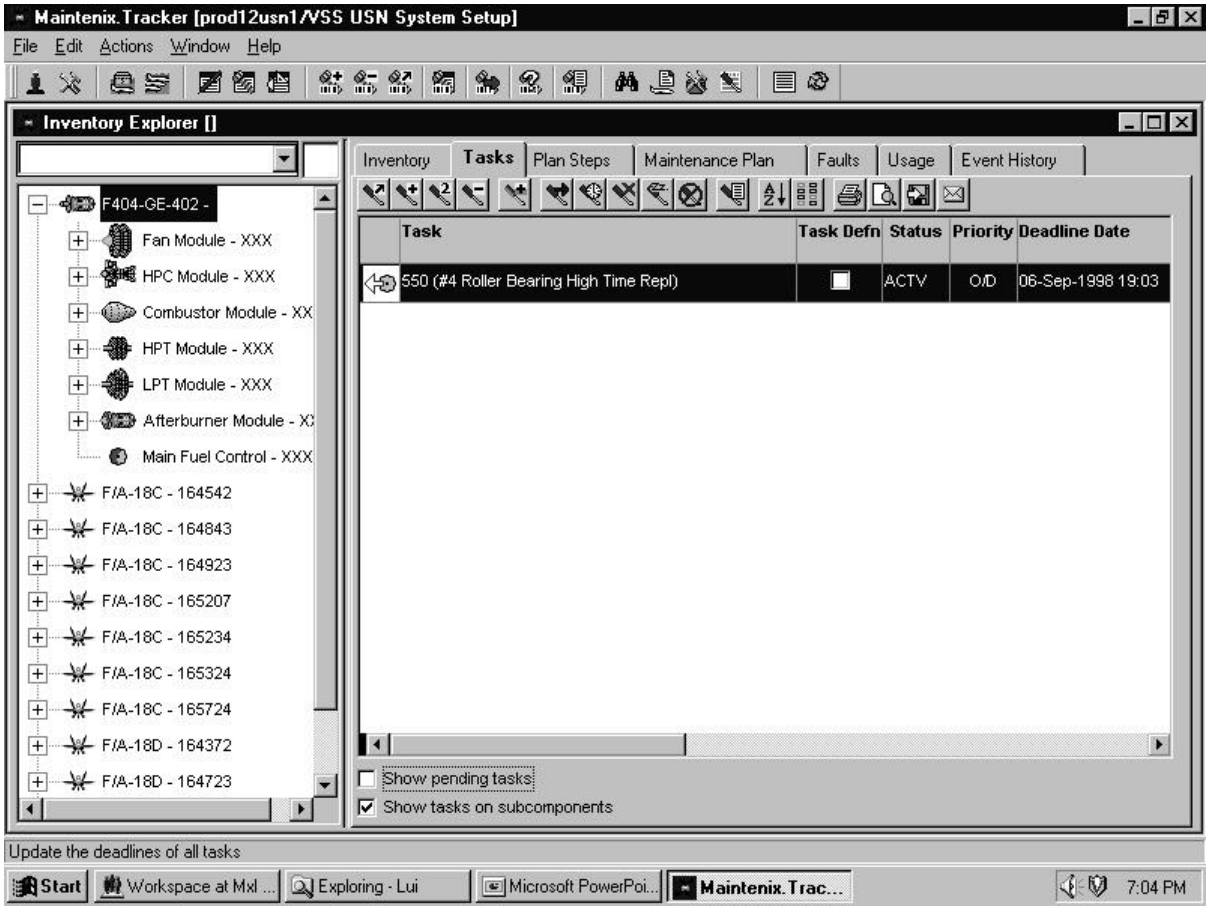
Aircraft Status is updated

- The PEDD upload installed the new engine in the aircraft logset
- The Status Board now shows the aircraft as ready to fly



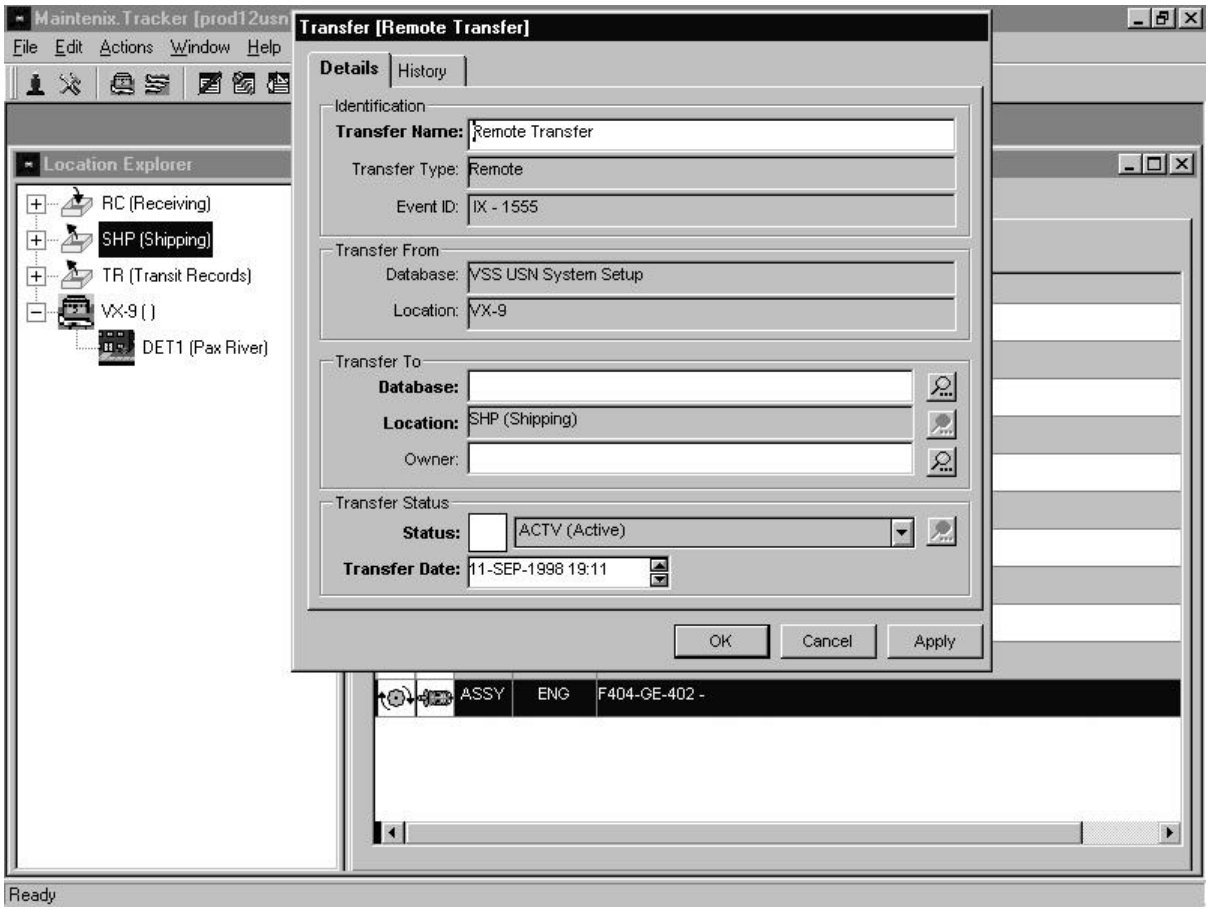
The Removed Engine's Logset is Intact

- The high-time engine is now out of the aircraft
- The engine logset is intact

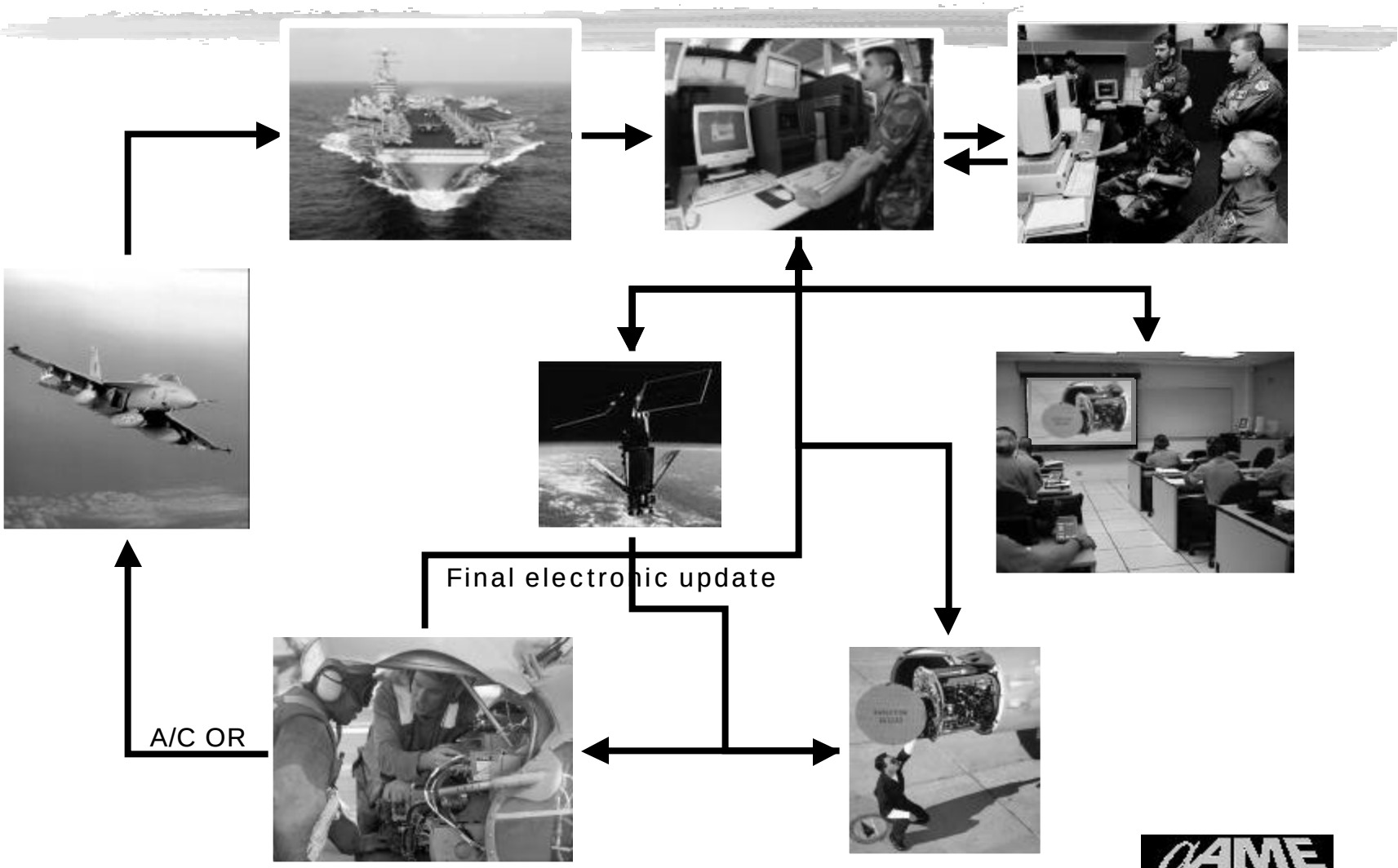


Transfer Engine Logset to IMA

- The engine (with the entire engine logset) is placed in the IMA inbox
- The transfer takes place automatically in the background



What's in the near Future?



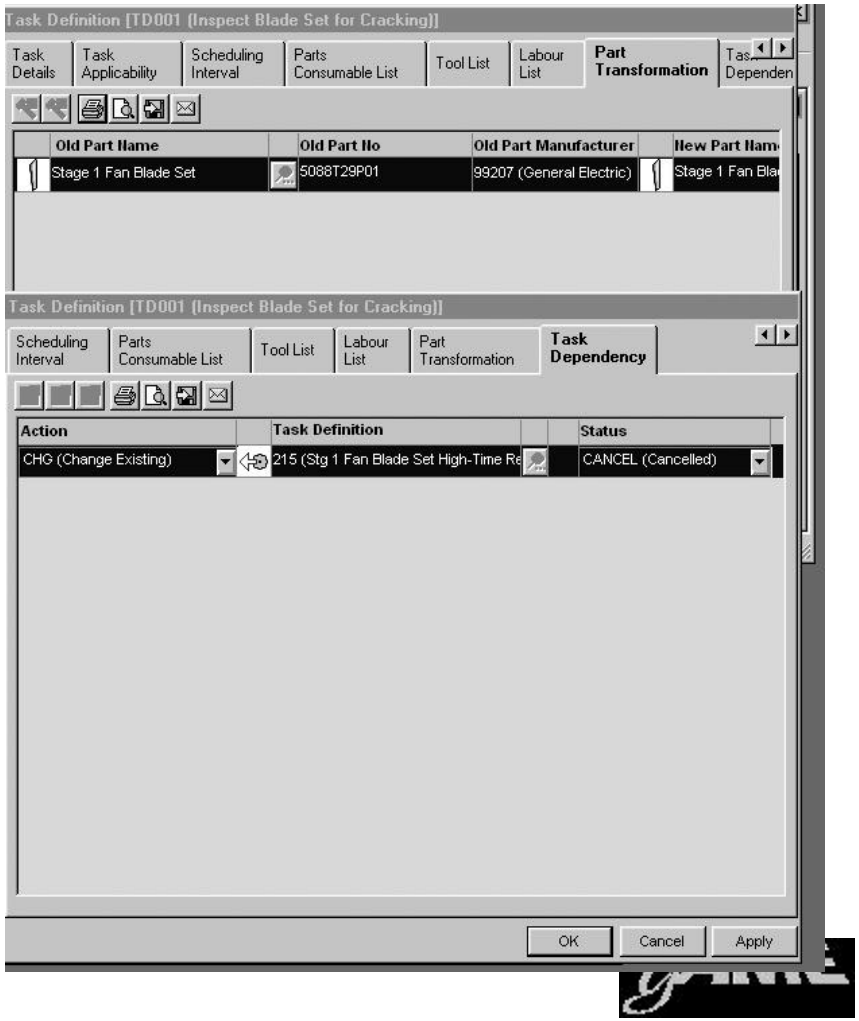
Additional Capabilities

Modify a Maintenance Plan

- What Occurs:
  - A new TD has been approved for the engine
  - "*Fleet Management*" creates the electronic TD task **ONCE** as a baseline data modification
  - This modification is broadcast automatically to affected sites.
  - The TD appears as a "due" task in the aircraft's maintenance due list.
- gAME Modules involved:
  - Maintenix/OOMA

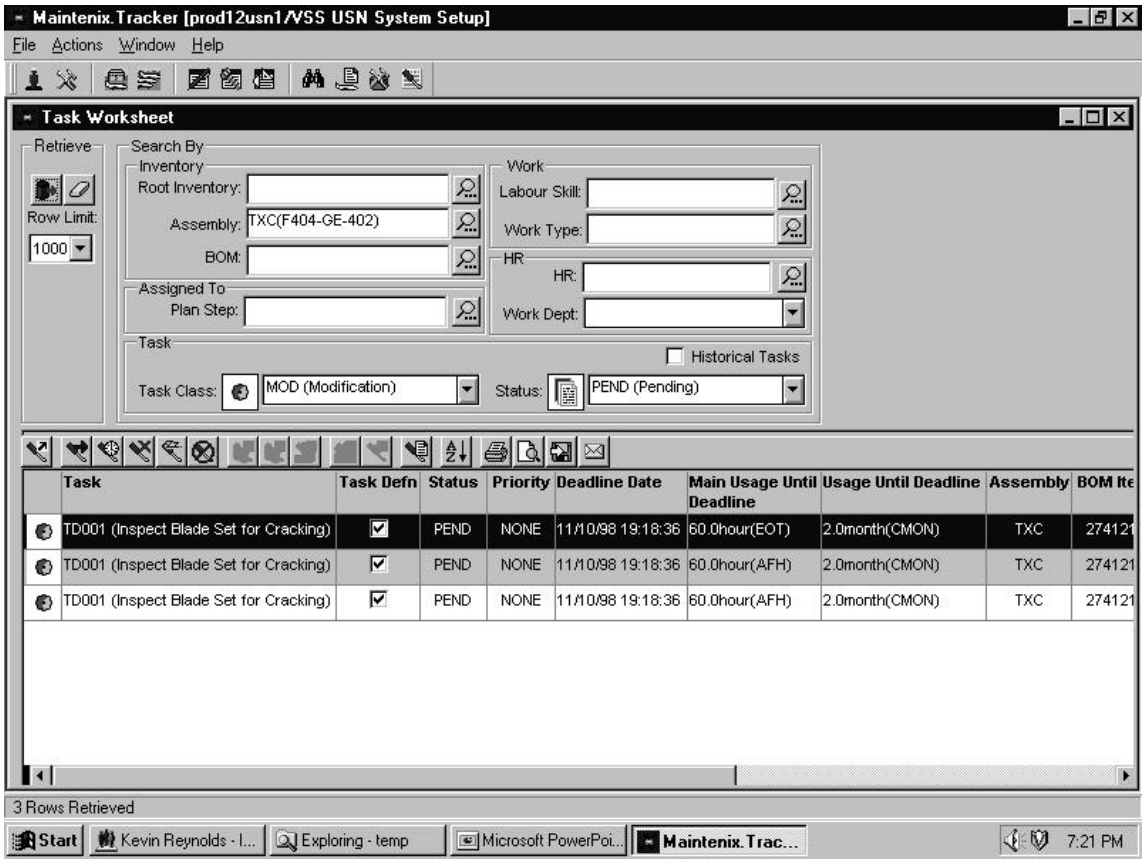
Define TD as a new Task

- TD is entered at central repository
- Define:
  - Applicability criteria
  - Tools required
  - Consumables required
  - Part and labor costs
  - Part Number Transformation



TD Broadcast to Those Affected

- TD task automatically created against target aircraft
- TD task automatically appears in aircraft / engine maintenance due list
- TD record follows the engine so status of TD always known

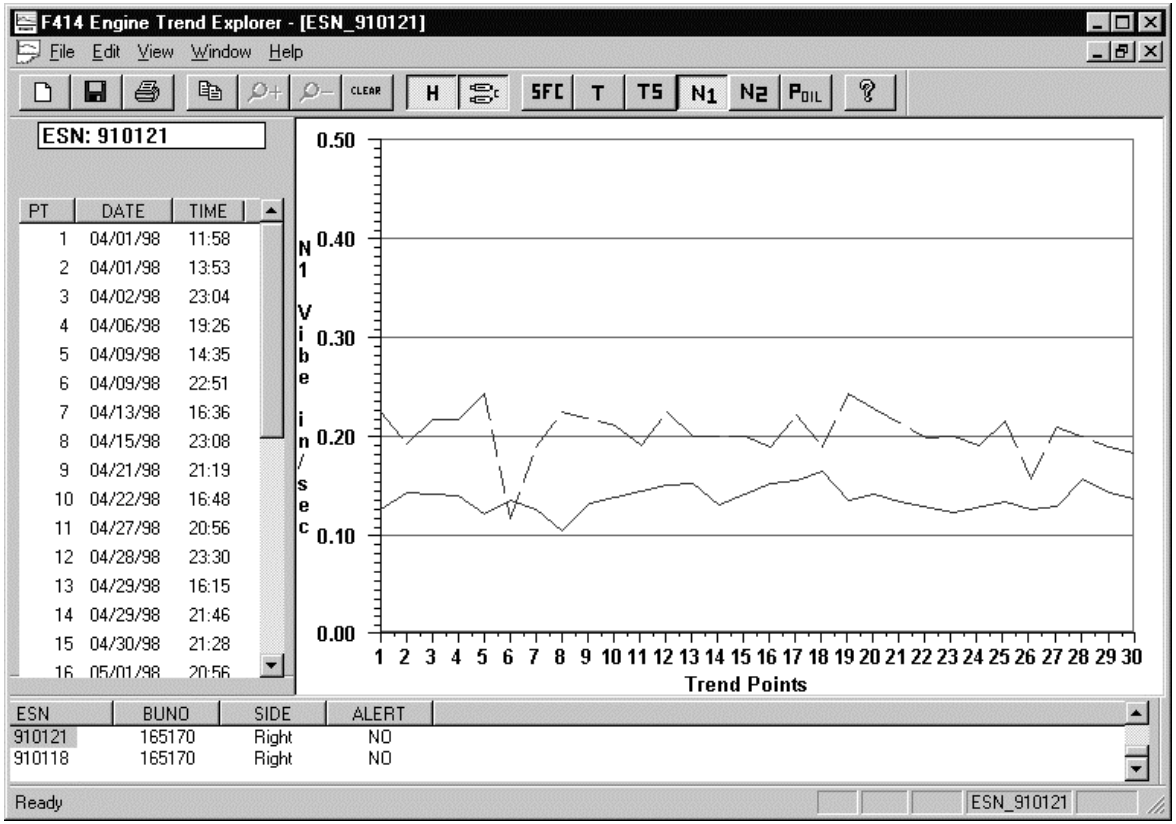


Offline Toolkit

- What Occurs:
  - Engine performance trending analysis
  - Engine flight summary
- gAME Modules involved:
  - F414 Trend Explorer
  - F414 Engine Flight Summary

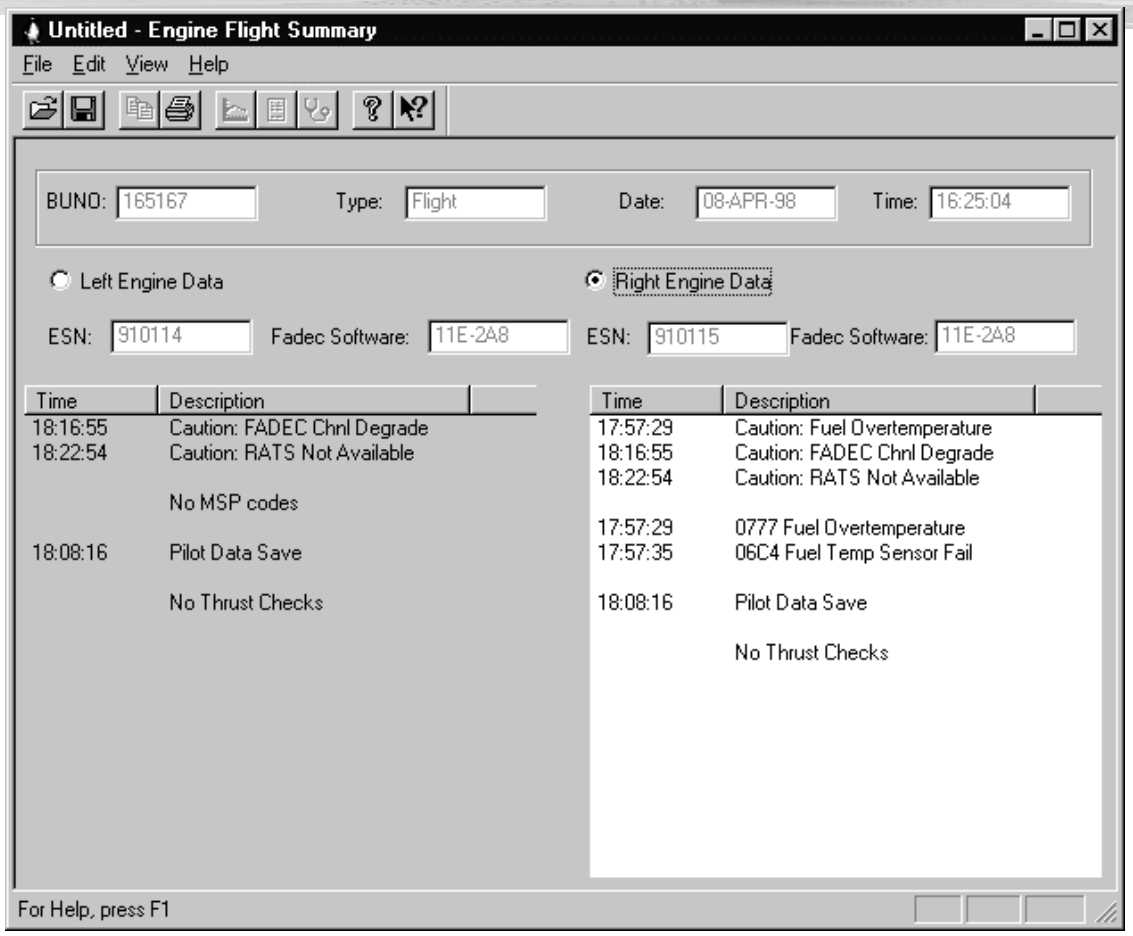
Typical Engine Trending

- Scenario
  - View engine degradations over time
- Display Engine Trend parameters & inform maintainer of trend alerts:
  - Specific Fuel Cons'n, Thrust, Turbine Exit Temperature, Fan Vibe, Core Vibe, Turbine Exit Pressure, Oil Pressure



Typical Flight Summary

- Scenario
  - Relate pilot gripes to MU records
- Purpose
  - Provide a breadth-first view of engine data for a selected ADF
  - MSP Codes, Cautions, Pilot Saves, Thrust Checks, Mission Profile



Conclusion

- Raytheon has several years experience managing the technologies specific to an Enterprise Maintenance Management task.
  - This experience provides significant contribution to overall program risk reduction.
- To Raytheon, gAME is not a product set! It represents an integrated, open architecture, modular solution to maintenance management challenges.
  - Methodologies demonstrated in sAME